

Appendix C, Part 3

Chemical Properties Data

Chemical Summary for . . .

p-TOLUENE SULFONIC ACID

PALLADIUM AND PALLADIUM CHLORIDE

PEROXYMONOSULFURIC ACID, MONOPOTASSIUM SALT

PHENOL-FORMALDEHYDE COPOLYMER

PHOSPHORIC ACID

POTASSIUM BISULFATE

POTASSIUM CARBONATE

POTASSIUM AND SODIUM CYANIDE

POTASSIUM HYDROXIDE

POTASSIUM PERSULFATE

POTASSIUM SULFATE

POTASSIUM SODIUM TARTRATE

SILVER

SODIUM BISULFATE

SODIUM CARBONATE

CHEMICAL SUMMARY FOR *p*-TOLUENE SULFONIC ACID

This chemical was identified by one or more suppliers as a bath ingredient for the electroless copper process. This summary is based on information retrieved from a systematic search limited to secondary sources (see Attachment C-1). The only exception is summaries of studies from unpublished TSCA submissions that may have been included. These sources include online databases, unpublished EPA information, government publications, review documents, and standard reference materials. No attempt has been made to verify information in these databases and secondary sources.

I. CHEMICAL IDENTITY AND PHYSICAL/CHEMICAL PROPERTIES

The chemical identity and physical/chemical properties of *p*-toluene sulfonic acid are summarized below.

CHEMICAL IDENTITY AND CHEMICAL/PHYSICAL PROPERTIES OF <i>p</i> -TOLUENE SULFONIC ACID		
Characteristic/Property	Data	Reference
CAS No.	104-15-4	
Common Synonyms	4-Methylbenzenesulfonic acid; tosic acid	Budavari et al. 1989
Molecular Formula	$C_7H_7O_2S$	
Chemical Structure	$CH_3C_6H_4SO_3H$	Budavari et al. 1989
Physical State	Crystalline; monoclinic leaflets or prisms	Budavari et al. 1989
Molecular Weight	172.2	Budavari et al. 1989
Melting Point	106-107°C (anhydrous) 38°C (metastable form)	Budavari et al. 1989
Boiling Point	140°C @ 20 mm Hg	Weast 1987
Water Solubility	67 g/100 mL (approximate)	Budavari et al. 1989
Specific Gravity	No data	
Vapor Density (air = 1)	No data	
K_{oc}	No data	
Log K_{ow}	No data	
Vapor Pressure	Low	HSDB 1995
Reactivity	NFPA reactivity, 1; normally stable, but may become unstable at elevated temperatures. Releases toxic fumes of SO_x when heated to decomposition.	HSDB 1995
Flammability	NFPA flammability, 1; must be preheated before ignition can occur.	HSDB 1995
Flash Point	184°C	HSDB 1995
Dissociation Constant	-1.34 (measured, uncertain)	CHEMFATE 1995
Henry's Law Constant	Very low due to low vapor pressure and high solubility.	HSDB 1995
Molecular Diffusivity Coefficient	No data	
Air Diffusivity Coefficient	No data	
Fish Bioconcentration Factor	No data, predicted low.	HSDB 1995
Taste Threshold	No data	
Conversion Factors	1 ppm = 7.03 mg/m ³ ; 1 mg/m ³ = 0.142 ppm	Calculated

a) Calculated utilizing: $mg/m^3 = ppm \times MW/24.5$ @ 25°C & 760 mm Hg.

II. ENVIRONMENTAL FATE

A. Environmental Release

p-Toluene sulfonic acid is manufactured for use as a chemical intermediate in the synthesis of dyes, antidiabetic drugs, chemicals used in detergents, and in the synthesis of other organic chemicals (Budavari et al. 1989; HSDB 1995). The exposure of humans to *p*-toluene sulfonic acid is primarily by dermal contact or inhalation during the manufacture or use of the chemical in occupational settings (HSDB 1995). Due to its high water solubility (about 67 g/100 mL), exposure may also occur in drinking water. *p*-Toluene sulfonic acid has been detected qualitatively in lowland river water and in groundwater in Britain (HSDB 1995). Based on a 1983 National Institute for Occupational Safety and Health (NIOSH) National

Occupational Hazard Survey, 16,526 workers are potentially exposed to *p*-toluene sulfonic acid in the U.S. (HSDB 1995).

B. Transport

Because of its water solubility, *p*-toluene sulfonic acid is expected to be highly mobile in soils and leach rapidly into ground waters. Once in the water, the chemical should not move into the atmosphere or onto sediments, but will degrade slowly (HSDB 1995).

C. Transformation/Persistence

1. Air — Very small amounts of *p*-toluene sulfonic acid enter the atmosphere from water solutions or from the involatile solid. Once in the air, it rapidly reacts with hydroxyl radicals resulting in a half-life of about 2 days (HSDB 1995).
2. Soil — Specific studies on the transformation/persistence of *p*-toluene sulfonic acid in the soil were not available; however, *p*-toluene sulfonic acid is expected to rapidly leach from the soil into ground water because of its high solubility. It is not expected to volatilize into the atmosphere from the soil (HSDB 1995). Although biodegradation is known to occur in water (see II.C.3.), specific information on the biodegradation of *p*-toluene sulfonic acid in the soil is not available (HSDB 1995).
3. Water — *p*-Toluene sulfonic acid primarily enters the environment in wastewater from its production and use. It is ionized in solution and does not significantly transfer into the sediment or into the atmosphere from the aquatic environment (HSDB 1995). It does not absorb light above 290 nm in solution and will not photodegrade or react with water under environmental conditions (HSDB 1995). Biodegradation is highly dependent on the presence of the proper acclimated microbial populations. Complete (100%) degradation in a few days was reported with activated sludge, whereas no degradation was seen for up to 64 days in the absence of activated microorganisms (HSDB 1995). *Pseudomonas* bacteria have been isolated from sludge and river water that can utilize *p*-toluene sulfonic acid as a sole carbon and sulfur source (CHEMFATE 1995; Kertesz et al. 1994).
4. Biota — Although no specific data are available, *p*-toluene sulfonic acid is not expected to bioconcentrate since it is highly water soluble and ionized in solution (HSDB 1995). Experiments with *Ricinus communis* L. (castor bean) have shown that plants absorb and transport *p*-toluene sulfonic acid to the leaves (Bromilow et al. 1993); however, it is not expected to bioconcentrate in food products (HSDB 1995).

CHEMICAL SUMMARY FOR PALLADIUM AND PALLADIUM CHLORIDE

This chemical was identified by one or more suppliers as a bath ingredient for the electroless copper and tin-palladium processes. This summary is based on information retrieved from a systematic search limited to secondary sources (see Attachment C-1). The only exception is summaries of studies from unpublished TSCA submissions that may have been included. These sources include online databases, unpublished EPA information, government publications, review documents, and standard reference materials. No attempt has been made to verify information in these databases and secondary sources.

I. CHEMICAL IDENTITY AND PHYSICAL/CHEMICAL PROPERTIES

The chemical identity and physical/chemical properties of palladium and palladium chloride are summarized below.

CHEMICAL IDENTITY AND CHEMICAL/PHYSICAL PROPERTIES OF PALLADIUM		
Characteristic/Property	Data	Reference
CAS No.	7440-05-3	
Common Synonyms	none found in the secondary sources searched	
Molecular Formula	Pd	
Chemical Structure	Pd	
Physical State	silver-white, ductile metal	HSDB 1995
Molecular Weight	106.4	HSDB 1995
Melting Point	not found	
Boiling Point	not found	
Water Solubility	insoluble	HSDB 1995
Density	12.02 g/cm ³	HSDB 1995
Vapor Density (air = 1)	not found	
K _{oc}	not found	
Log K _{ow}	not found	
Vapor Pressure	not found	
Reactivity	appreciably volatile at high temperatures; is converted to the oxide at red heat; can absorb and retain over 800 times its volume of hydrogen, resulting in an expansion of several percent; incompatible with arsenic, carbon, ozonides, sodium tetrahydroborate, and sulfur	HSDB 1995
Flammability	palladium black or finely divided palladium is usually pyrophoric and requires handling precautions; the dust of palladium can be a fire and explosion hazard	HSDB 1995
Flash Point	not found	
Dissociation Constant	not found	
Henry's Law Constant	not found	
Molecular Diffusivity Coefficient	not found	
Air Diffusivity Coefficient	not found	
Fish Bioconcentration Factor	not found	
Odor Threshold	not found	
Conversion Factors	not applicable	

APPENDIX C

CHEMICAL IDENTITY AND CHEMICAL/PHYSICAL PROPERTIES OF PALLADIUM CHLORIDE		
Characteristic/Property	Data	Reference
CAS No.	7647-10-1	
Common Synonyms	palladium(2+) chloride; palladous chloride	RTECS 1995
Molecular Formula	PdCl ₂	
Chemical Structure	Cl ₂ -Pd	
Physical State	dark red cubic needles	HSDB 1995
Molecular Weight	177.30	HSDB 1995
Melting Point	678-680°C; deliquescent, decomposes at 500°C	HSDB 1995
Boiling Point	not found	
Water Solubility	soluble	HSDB 1995
Density	6.0 g/m ³	HSDB 1995
Vapor Density (air = 1)	not found	
K _{oc}	not found	
Log K _{ow}	not found	
Vapor Pressure	not found	
Reactivity	not found	
Flammability	not found	
Flash Point	not found	
Dissociation Constant	not found	
Henry's Law Constant	not found	
Molecular Diffusivity Coefficient	not found	
Air Diffusivity Coefficient	not found	
Fish Bioconcentration Factor	not found	
Odor Threshold	not found	
Conversion Factors	1 ppm = 7.25 mg/m ³ 1 mg/m ³ = 0.138 ppm	Calculated using: ppm = mg/m ³ x 24.45/m.w.

II. ENVIRONMENTAL FATE

A. Environmental Release

Palladium occurs in the earth's crust, at the concentration of 0.2 ppm, in association with the rare metals of Group VIII (platinum, ruthenium, rhodium, osmium, and iridium) (Venugopal and Luckey 1978; Amdur et al. 1991). The release of palladium to the environment may occur as a result of the mining, refining, fabrication, and use of the metal (Seiler and Sigel 1988). Palladium has been incorporated into catalysts used to control emissions in automobile exhausts; however, the minute quantities emitted are in a biologically inert form (Seiler and Sigel 1988). No significant concentrations were detected near busy highways following 10 years of this use (Seiler and Sigel 1988).

B. Transport

No information was found in the secondary sources searched regarding the environmental transport of palladium or palladium chloride.

C. Transformation/Persistence

1. Air — No information was found in the secondary sources searched regarding the transformation/persistence of palladium or palladium chloride in air.
2. Soil — No information was found in the secondary sources searched regarding the transformation/persistence of palladium or palladium chloride in soil.
3. Water — No information was found in the secondary sources searched regarding the transformation/persistence of palladium or palladium chloride in water.
4. Biota — There is no evidence that palladium accumulates in mammals following ingestion (HSDB 1995); however, the metal was present in all tissues analyzed from rats 104 days after intravenous injection (Beliles 1994a).

CHEMICAL SUMMARY FOR PEROXYMONOSULFURIC ACID, MONOPOTASSIUM SALT

This chemical was identified by one or more suppliers as a bath ingredient for the electroless copper, conductive polymer, and graphite processes. This summary is based on information retrieved from a systematic search limited to secondary sources (see Attachment C-1). These sources include online databases, unpublished EPA information, government publications, review documents, and standard reference materials. No attempt has been made to verify information in these databases and secondary sources.

I. CHEMICAL IDENTITY AND PHYSICAL/CHEMICAL PROPERTIES

The chemical identity and physical/chemical properties of peroxymonosulfuric acid, monopotassium salt are summarized below.

CHEMICAL IDENTITY AND CHEMICAL/PHYSICAL PROPERTIES OF PEROXYMONOSULFURIC ACID, MONOPOTASSIUM SALT

Characteristic/Property	Data	Reference
CAS No.	10058-23-8	
Common Synonyms	monopotassium peroxymonosulfurate; potassium peroxymonosulfate	RTECS 1995
Molecular Formula	HO ₅ SK	RTECS 1995
Chemical Structure	$ \begin{array}{c} \text{O} \\ \\ \text{KOSO} \\ \\ \text{O} \end{array} $	
Physical State	no data	
Molecular Weight	152.17	RTECS 1995
Melting Point	no data	
Boiling Point	no data	
Water Solubility	no data	
Density	no data	
Vapor Density (air = 1)	no data	
K _{oc}	no data	
Log K _{ow}	no data	
Vapor Pressure	no data	
Reactivity	no data	
Flammability	no data	
Flash Point	no data	
Dissociation Constant	no data	
Henry's Law Constant	no data	
Molecular Diffusivity Coefficient	no data	
Air Diffusivity Coefficient	no data	
Fish Bioconcentration Factor	no data	
Odor Threshold	no data	
Conversion Factors	no data	

II. ENVIRONMENTAL FATE

A. Environmental Release

No information on the environmental release of peroxymonosulfuric acid, monopotassium salt were found in the secondary sources searched.

B. Transport

No information on the transport of peroxymonosulfuric acid, monopotassium salt was found in the secondary sources searched.

C. Transformation/Persistence

No information on the transformation/persistence of peroxymonosulfuric acid, monopotassium salt in air, soil, water, or biota was found in the secondary sources searched.

CHEMICAL SUMMARY FOR PHENOL-FORMALDEHYDE COPOLYMER

This chemical was identified by one or more suppliers as a bath ingredient for the conductive ink process. This summary is based on information retrieved from a systematic search limited to secondary sources (see Attachment C-1). The only exception is summaries of studies from unpublished TSCA submissions that may have been included. These sources include online databases, unpublished EPA information, government publications, review documents, and standard reference materials. No attempt has been made to verify information in these databases and secondary sources.

I. CHEMICAL IDENTITY AND PHYSICAL/CHEMICAL PROPERTIES

The chemical identity and physical/chemical properties of phenol-formaldehyde copolymer are summarized below.

CHEMICAL IDENTITY AND CHEMICAL/PHYSICAL PROPERTIES OF PHENOL-FORMALDEHYDE COPOLYMER

Characteristic/Property	Data	Reference
CAS No.	9003-35-4	Harris and Sarvadi 1994
Common Synonyms	Phenol-formaldehyde resin	Harris and Sarvadi 1994
Molecular Formula	(C ₆ H ₆ O.CH ₂ O) _n	Harris and Sarvadi 1994
Chemical Structure	not found	
Physical State	solid (when cured) viscous liquid (uncured)	
Molecular Weight	300-700 (one-step process) ^a 1200-1500 (two-step process) ^a Several hundred thousand (cured resin)	Harris and Sarvadi 1994 Harris and Sarvadi 1994 Harris and Sarvadi 1994
Melting Point	not found	
Boiling Point	not found	
Water Solubility	Soluble (non-cured resin) Insoluble (cured resin)	Harris and Sarvadi 1994 Harris and Sarvadi 1994
Density	not found	
Vapor Density (air = 1)	not found	
K _{oc}	not found	
Log K _{ow}	not found	
Vapor Pressure	not found	
Reactivity	High chemical resistance	Harris and Sarvadi 1994
Flammability	Fire retardant	Harris and Sarvadi 1994
Flash Point	not found	
Dissociation Constant	not found	
Henry's Law Constant	not found	
Molecular Diffusivity Coefficient	not found	
Air Diffusivity Coefficient	not found	
Fish Bioconcentration Factor	not found	
Odor Threshold	not found	
Conversion Factors	not found	

a) "One-step" and "two-step" refer to the manufacturing process used to make the resin.

II. ENVIRONMENTAL FATE

A. Environmental Release

Phenol-formaldehyde (PF) copolymer is used in a wide variety of products including wood composites (plywood, particleboard, fiberboard), molding materials (in appliances, electric controls, telephones, and wiring services), and as a binder for thermal and sound insulation materials (e.g., glass fibers and mineral wool) (Opresko 1991). There are no reports of any detrimental toxic effects from cured phenolic resins; therefore, the greatest hazards associated with these substances is expected to occur during the manufacture, processing, and handling of the uncured resin (Opresko 1991). However, loss of both phenol and formaldehyde has been observed for many months after fabrication of foam insulation for refrigerators (Opresko 1991). Phenol was identified as one of a

number of volatile organic compounds found in indoor air as a result of emissions from construction and interior finish materials and adhesives used in such products (Opresko 1991). A study on workers exposed to phenolic resin fumes for periods of less than 1 year to more than 5 years reported PF component levels of 7-10 mg phenol/m³ and 0.5-1.0 mg formaldehyde/m³ (Opresko 1991). Most environmental release of PF components would likely come from such manufacturing operations. Both monomeric components of PF copolymer, phenol and formaldehyde, have been profiled separately (U.S. EPA 1995a, 1996a).

B. Transport

No information was found in the secondary sources searched regarding the environmental transport of PF copolymer. Cured PF resin is a water insoluble solid and would not be a likely groundwater contaminant. Offgassing of PF component monomers during processing and, to a lesser extent, after curing would be the most probable mode of environmental transport.

C. Transformation/Persistence

1. Air — No information was found in the secondary sources searched regarding the transformation/persistence of PF copolymer in air.
2. Soil — PF copolymer is highly resistant to biological decay (Harris and Sarvadi 1994). This fact, coupled with its low water solubility, suggest that PF copolymer would be persistent in soil.
3. Water — No information was found in the secondary sources searched regarding the transformation/persistence of PF copolymer in water. Because of its very low water solubility, cured PF copolymer is not likely to be a contaminant of groundwater.
4. Biota — No information was found in the secondary sources searched regarding the bioaccumulation of PF copolymer.

CHEMICAL SUMMARY FOR PHOSPHORIC ACID

This chemical was identified by one or more suppliers as a bath ingredient for the conductive polymer and tin-palladium processes. This summary is based on information retrieved from a systematic search limited to secondary sources (see Attachment C-1). These sources include online databases, unpublished EPA information, government publications, review documents, and standard reference materials. No attempt has been made to verify information in these databases and secondary sources.

I. CHEMICAL IDENTITY AND PHYSICAL/CHEMICAL PROPERTIES

The chemical identity and physical/chemical properties of phosphoric acid are summarized below.

CHEMICAL IDENTITY AND CHEMICAL/PHYSICAL PROPERTIES OF PHOSPHORIC ACID		
Characteristic/Property	Data	Reference
CAS No.	7664-38-2	
Common Synonyms	orthophosphoric acid	Budavari et al.1989
Molecular Formula	H ₃ O ₄ P	Budavari et al.1989
Chemical Structure	$ \begin{array}{c} \text{HO} \quad \text{O} \\ \quad \quad \parallel \\ \quad \quad \text{P} - \text{OH} \\ \quad \quad / \\ \text{HO} \end{array} $	Budavari et al.1989
Physical State	unstable, orthorhombic crystals or syrupy liquid	Budavari et al.1989
Molecular Weight	98.00	Budavari et al.1989
Melting Point	42.35	Budavari et al.1989
Boiling Point	@ 213° C losing ½ water	HSDB 1995
Water Solubility	548g/100 mL	HSDB 1995
Density	1.8741 @ 25 (100% soln.)	Budavari et al.1989
Vapor Density (air = 1)	3.4	HSDB 1995
K _{oc}	no data	
Log K _{ow}	no data	
Vapor Pressure	0.03 mm Hg @ 20°C	
Reactivity	Hot concd acid attacks porcelain and granite ware	Budavari et al.1989
	Reacts w/metals to liberate flammable H ₂ gas	HSDB 1995
	sodium tetraborate; aldehydes; cyanides	HSDB 1995
	bleach; ammonia	NIOSH 1994
Flammability	not combustible, but contact w/common metals liberates hydrogen	HSDB 1995
Flash Point	no data	
Dissociation Constant	K ₁ =7.107 x 10 ⁻³	Budavari 1989
Henry's Law Constant	no data	
Molecular Diffusivity Coefficient	no data	
Air Diffusivity Coefficient	no data	
Fish Bioconcentration Factor	no data	
Odor Threshold	Odorless	HSDB 1995
Conversion Factors	no data	

II. ENVIRONMENTAL FATE

A. Environmental Release

Of the total 206.6 million pounds of phosphoric acid released into the environment in 1992, as reported to the TRI by certain types of U.S. industries, 1.2 million pounds were released into the atmosphere, 158.7 million pounds were released into ground or surface waters, and 46.7 million pounds were released onto the land (TRI92 1994).

B. Transport

When spilled onto soil, phosphoric acid will infiltrate downward, the rate being greater with lower concentrations because of reduced viscosity. Upon reaching the groundwater table, phosphoric acid will move in the direction of the groundwater flow (HSDB 1995).

C. Transformation/Persistence

1. Air — Phosphoric acid may be present in air as a mist or a vapor, but it exists primarily as a mist because of its low volatility and its affinity for water (IARC 1992).
2. Soil — During transport through soil, phosphoric acid will dissolve some of the soil material, in particular carbonate based materials. The acid will be neutralized to some degree with adsorption of the proton and phosphate ions also possible. However significant amounts of acid will remain for transport to groundwater (HSDB 1995).
3. Water — Upon reaching groundwater, a contaminated plume will be produced with dilution and dispersion serving to reduce the acid concentration (HSDB 1995). However, while acidity may be reduced readily by natural water hardness minerals, the phosphate may persist indefinitely (HSDB 1995).
4. Biota — No information was found in the secondary sources searched regarding the transformation/persistence of phosphoric acid in biota. Phosphoric acid is a natural constituent of many fruits and their juices (HSDB 1995).

CHEMICAL SUMMARY FOR POTASSIUM BISULFATE

This chemical was identified by one or more suppliers as a bath ingredient for the electroless copper process. This summary is based on information retrieved from a systematic search limited to secondary sources (see Attachment C-1). The only exception is summaries of studies from unpublished TSCA submissions that may have been included. These sources include online databases, unpublished EPA information, government publications, review documents, and standard reference materials. No attempt has been made to verify information in these databases and secondary sources.

I. CHEMICAL IDENTITY AND PHYSICAL/CHEMICAL PROPERTIES

The chemical identity and physical/chemical properties of potassium bisulfate are summarized below.

CHEMICAL IDENTITY AND CHEMICAL/PHYSICAL PROPERTIES OF POTASSIUM BISULFATE		
Characteristic/Property	Data	Reference
CAS No.	7646-93-7	
Common Synonyms	monopotassium sulfate; potassium acid sulfate; potassium bisulphate; sulfuric acid, monopotassium salt	RTECS 1995
Molecular Formula	KHSO ₄	JT Baker Inc. 1992
Chemical Structure	H-O ₃ -S-K	RTECS 1995
Physical State	white, deliquescent crystals	Budavari et al. 1989
Molecular Weight	136.17	Budavari et al. 1989
Melting Point	197°C (loses water at higher temperatures, and is converted to pyrosulfate)	Budavari et al. 1989
Boiling Point	decomposes	Fisher Scientific 1991
Water Solubility	soluble in 1.8 parts water; 0.85 parts boiling water	Budavari et al. 1989
Density	2.24	Budavari et al. 1989
Vapor Density (air = 1)	no data	
K _{oc}	no data	
Log K _{ow}	no data	
Vapor Pressure	negligible	Fisher Scientific 1991
Reactivity	0 (nonreactive, NFPA classification); can form an explosive mixture; acidic in solution	Lockheed Martin 1989 Sax and Lewis 1989 Fisher Scientific 1991
Flammability	0 (noncombustible, NFPA classification)	Lockheed Martin 1989a
Flash Point	no data	
Dissociation Constant	no data	
Henry's Law Constant	no data	
Molecular Diffusivity Coefficient	no data	
Air Diffusivity Coefficient	no data	
Fish Bioconcentration Factor	no data	
Odor Threshold	no data; odorless; sulfur odor	JT Baker Inc. 1992 Fisher Scientific 1991
Conversion Factors	no data	

II. ENVIRONMENTAL FATE

A. Environmental Release

Potassium bisulfate is a deliquescent solid that is soluble in water. It is used as flux in the analysis of ores, and as a cathartic (Budavari et al. 1989). No data were found on the environmental releases of potassium bisulfate in the secondary sources searched. The chemical is not listed on U.S. EPA's TRI, requiring certain U.S. industries to report on chemical releases to the environment (TRI93 1995).

B. Transport

No data were found on the environmental transport of potassium bisulfate in the secondary sources searched. Low vapor pressure and its water solubility suggest that it would remain in the water phase.

C. Transformation/Persistence

No data were found on the transformation/persistence of potassium bisulfate in the secondary sources searched.

CHEMICAL SUMMARY FOR POTASSIUM CARBONATE

This chemical was identified by one or more suppliers as a bath ingredient for the carbon, graphite, and tin-palladium processes. This summary is based on information retrieved from a systematic search limited to secondary sources (see Attachment C-1). The only exception is summaries of studies from unpublished TSCA submissions that may have been included. These sources include online databases, unpublished EPA information, government publications, review documents, and standard reference materials. No attempt has been made to verify information in these databases and secondary sources.

I. CHEMICAL IDENTITY AND PHYSICAL/CHEMICAL PROPERTIES

The chemical identity and physical/chemical properties of potassium carbonate are summarized below.

CHEMICAL IDENTITY AND CHEMICAL/PHYSICAL PROPERTIES OF POTASSIUM CARBONATE		
Characteristic/Property	Data	Reference
CAS No.	584-08-7	
Common Synonyms	salt of tartar; pearl ash	Budavari et al. 1989
	potash	RTECS 1995
Molecular Formula	K ₂ CO ₃	Budavari et al. 1989
Chemical Structure	K ₂ CO ₃	
Physical State	hygroscopic, odorless granules, or granular powder	Budavari et al. 1989
Molecular Weight	138.20	Budavari et al. 1989
Melting Point	891 ° C	Budavari et al. 1989
Boiling Point	no data	
Water Solubility	sol. in 1 part cold, 0.7 pts boiling H ₂ O	Budavari et al. 1989
	112 g/100 mL cold water	HSDB 1995
Density	2.29	Budavari et al. 1989
Vapor Density (air = 1)	no data	
K _{oc}	no data	
Log K _{ow}	no data	
Vapor Pressure	no data	
Reactivity	hygroscopic; aqueous soln strongly alkaline	Budavari et al. 1989
	violent reaction with ClF ₃	HSDB 1995
Flammability	no data	
Flash Point	no data	
Dissociation Constant	no data	
Henry's Law Constant	no data	
Molecular Diffusivity Coefficient	no data	
Air Diffusivity Coefficient	no data	
Fish Bioconcentration Factor	no data	
Odor Threshold	odorless	Budavari et al. 1989
Conversion Factors	no data	

II. ENVIRONMENTAL FATE

A. Environmental Release

Potassium carbonate is a naturally occurring compound with deposits found in southeastern New Mexico (HSDB 1995). It is one of the major inorganic particle components of cigarette smoke (Churg and Stevens 1992). Potassium carbonate is not one of the compounds reported to the TRI by certain types of U.S. industries.

B. Transport

No information was found in the secondary sources searched regarding the transport of potassium carbonate.

C. Transformation/Persistence

No information was found in the secondary sources searched regarding the transformation/persistence of potassium carbonate in air, soil, water, or biota.

CHEMICAL SUMMARY FOR POTASSIUM AND SODIUM CYANIDE

These chemicals were identified by one or more suppliers as a bath ingredient for the electroless copper process. This summary is based on information retrieved from a systematic search limited to secondary sources (see Attachment C-1). The only exception is summaries of studies from unpublished TSCA submissions that may have been included. These sources include online databases, unpublished EPA information, government publications, review documents, and standard reference materials. No attempt has been made to verify information in these databases and secondary sources.

I. CHEMICAL IDENTITY AND PHYSICAL/CHEMICAL PROPERTIES

The chemical identity and physical/chemical properties of potassium and sodium cyanide are summarized below.

CHEMICAL IDENTITY AND CHEMICAL/PHYSICAL PROPERTIES OF POTASSIUM CYANIDE		
Characteristic/Property	Data	Reference
CAS No.	151-50-8	
Common Synonyms	hydrocyanic acid, potassium salt	RTECS 1995
Molecular Formula	CKN	Budavari et al. 1989
Chemical Structure	KCN	Budavari et al. 1989
Physical State	white deliquescent granular powder or fused pieces	Budavari et al. 1989
Molecular Weight	65.11	Budavari et al. 1989
Melting Point	634°C	Budavari et al. 1989
Boiling Point	no data	
Water Solubility	71.6 g/100 mL at 25°C	ATSDR 1995
Density	1.553 g/cm ³ at 20°C	U.S. EPA 1985c
Vapor Density (air = 1)	no data	
K _{oc}	3.0 (calculated)	HSDB 1995
Log K _{ow}	no data	
Vapor Pressure	no data	
Reactivity	slowly decomposed by water and very rapidly by acids to release HCN; pH of 0.1 N solution = 11; incompatible with strong oxidizers such as nitrates, chlorates, and acid salts	HSDB 1995
Flammability	not flammable itself, but contact with acids releases highly flammable HCN gas	HSDB 1995
Flash Point	no data	
Dissociation Constant	no data	
Henry's Law Constant	no data	
Molecular Diffusivity Coefficient	no data	
Air Diffusivity Coefficient	no data	
Fish Bioconcentration Factor	0.3 (calculated)	HSDB 1995
Odor Threshold	faint odor of bitter almonds	ACGIH 1991
Conversion Factors	1 ppm = 2.707 mg/m ³ 1 mg/m ³ = 0.369 ppm	U.S. EPA 1985c

APPENDIX C

CHEMICAL IDENTITY AND CHEMICAL/PHYSICAL PROPERTIES OF SODIUM CYANIDE		
Characteristic/Property	Data	Reference
CAS No.	143-33-9	
Common Synonyms	hydrocyanic acid, sodium salt	RTECS 1995
Molecular Formula	CNaN	Budavari et al. 1989
Chemical Structure	NaCN	Budavari et al. 1989
Physical State	white granules or fused pieces	Budavari et al. 1989
Molecular Weight	49.07	Budavari et al. 1989
Melting Point	563 °C	Budavari et al. 1989
Boiling Point	1500 °C	ACGIH 1991
Water Solubility	freely soluble	Budavari et al. 1989
Density	1.60-1.62 g/cm ³ (temperature not given)	U.S. EPA 1985c
Vapor Density (air = 1)	1.7	JT Baker Inc. 1992b
K _{oc}	no data	
Log K _{ow}	-0.44 (K _{ow})	U.S. EPA 1985c
Vapor Pressure	0.76 mg Hg at 800 °C	U.S. EPA 1985c
Reactivity	contact with acids and acid salts forms HCN immediately; incompatible with strong oxidizers, such as nitrates, chlorates, and acid salts; aqueous solution is strongly alkaline	HSDB 1995
Flammability	not combustible itself, but contact with acids releases highly flammable HCN gas	HSDB 1995
Flash Point	no data	
Dissociation Constant	no data	
Henry's Law Constant	no data	
Molecular Diffusivity Coefficient	no data	
Air Diffusivity Coefficient	no data	
Fish Bioconcentration Factor	0.27 (calculated)	U.S. EPA 1985c
Odor Threshold	faint odor of bitter almonds	HSDB 1995
Conversion Factors	1 ppm = 2.037 mg/m ³ 1 mg/m ³ = 0.491 ppm	U.S. EPA 1985c

II. ENVIRONMENTAL FATE

A. Environmental Release

Potassium and sodium cyanide are used in the extraction of gold and silver ores; electroplating; metal cleaning; as insecticides and fumigants; in heat treatment of metals; and as raw materials in the manufacture of dyes, pigments, nylon, and chelating agents (ACGIH 1991). In 1993, releases of cyanide compounds to environmental media, as reported to the TRI by certain types of industries, totaled about 3,291,307 pounds. Of this amount, a total of 898,728 pounds was released to the atmosphere, 97,666 pounds to surface waters, 2,288,870 pounds to underground injection, and 6,043 pounds to land (TRI93 1995). Potassium and sodium cyanide are not reported separately.

B. Transport

Potassium and sodium cyanide release hydrocyanic acid (HCN) to the environment. HCN is expected to volatilize from aquatic media and soils (U.S. EPA 1984c). Cyanide has the potential to be transported in air over long distances from its emission source. Alkali cyanides can be removed from air by both wet and dry deposition (ATSDR 1995). Because of their high water solubility and low sorption characteristics, cyanides are expected to leach through soils into groundwater (U.S. EPA 1985c).

C. Transformation/Persistence

1. Air — Most cyanide in the atmosphere is likely present as HCN gas, but small amounts of metal cyanides may be present as particulate matter in air. HCN slowly reacts with hydroxyl radicals in the air; the calculated half-life for this reaction is approximately 11 years, indicating no significant loss to the troposphere. Physical transfer, such as wet and dry deposition, may

dominate the fate of cyanides in the atmosphere. Considering the water solubility of alkali cyanides, wet deposition appears to be more important process (U.S. EPA 1984c).

2. Soil — In soils, the fate of cyanides is pH dependent. In acidic soils, the loss of HCN through volatilization may be the predominant mechanism of loss from soil surfaces. In subsurface soils, cyanides that are present at low concentrations (below the toxic levels for microorganisms) may undergo some microbial degradation (U.S. EPA 1984c). Because of their low soil sorption characteristics and high water solubility of cyanides, some may leach through the soil. However, cyanides have been rarely detected in groundwater. In basic soils, the mobility of cyanides is expected to be greatly restricted (U.S. EPA 1984c).
3. Water — The alkali metal salts, such as sodium and potassium cyanide, are very soluble in water and the resulting cyanide ions readily hydrolyze with water to form HCN. The extent of HCN formation is mainly dependent upon water temperature and pH. At 20°C and a pH of 8 or below, at least 96% of free cyanide exists as HCN (U.S. EPA 1980). Since the pH of most natural waters ranges between 6 and 9, a large percentage of cyanides will be present in the form of HCN which readily volatilizes from water. Cyanides can be biodegraded at low concentrations in water by single and mixed organisms. Both aerobic and anaerobic microbial degradation of cyanides during sewage treatment plant operations have been demonstrated (U.S. EPA 1985c).
4. Biota — Potassium and sodium cyanide are not expected to bioaccumulate in aquatic organisms (U.S. EPA 1984c).

CHEMICAL SUMMARY FOR POTASSIUM HYDROXIDE

This chemical was identified by one or more suppliers as a bath ingredient for the electroless copper, carbon, and non-formaldehyde electroless copper processes. This summary is based on information retrieved from a systematic search limited to secondary sources (see Attachment C-1). The only exception is summaries of studies from unpublished TSCA submissions that may have been included. These sources include online databases, unpublished EPA information, government publications, review documents, and standard reference materials. No attempt has been made to verify information in these databases and secondary sources.

I. CHEMICAL IDENTITY AND PHYSICAL/CHEMICAL PROPERTIES

The chemical identity and physical/chemical properties of potassium hydroxide are summarized below.

CHEMICAL IDENTITY AND CHEMICAL/PHYSICAL PROPERTIES OF POTASSIUM HYDROXIDE		
Characteristic/Property	Data	Reference
CAS No.	1310-58-3	
Common Synonyms	caustic potash; lye; potassium hydrate	HSDB 1995
Molecular Formula	KOH	
Chemical Structure	K-OH	
Physical State	white or slightly yellow lumps, rods, pellets; deliquesces as moisture and carbon dioxide are absorbed from the air	HSDB 1995
Molecular Weight	56.11	HSDB 1995
Melting Point	360 °C	Pierce 1994
Boiling Point	1324 °C	HSDB 1995
Water Solubility	100 g/90 mL; aqueous solution may have pH ≥ 13	HSDB 1995; Pierce 1994a
Density	2.044 mg/mL	HSDB 1995
Vapor Density (air = 1)	not found	
K _{oc}	not found	
Log K _{ow}	not found	
Vapor Pressure	1 mm Hg @ 714 °C	HSDB 1995
pH	14 (1.0 M solution)	Lockheed Martin 1994b
Reactivity	heat generated when KOH dissolves in water, alcohol, or acid-treated solution; reacts violently with <i>O</i> -nitrophenol; heating with tetrachloroethane, 1,2-dichloroethylene, or phosphorus forms spontaneously flammable compounds; explosive when heated or reacted with certain compounds	HSDB 1995
Flammability	will not burn; however, may react with water and other substances and generate heat sufficient to ignite combustible materials	HSDB 1995; NIOSH 1994
Flash Point	not flammable	
Dissociation Constant	not found	
Henry's Law Constant	not found	
Molecular Diffusivity Coefficient	not found	
Air Diffusivity Coefficient	not found	
Fish Bioconcentration Factor	not found	
Odor Threshold	not found	
Conversion Factors	1 ppm = 2.29 mg/m ³ 1 mg/m ³ = 0.44 ppm	Calculated using: ppm = mg/m ³ x 24.45/m.w.

II. ENVIRONMENTAL FATE

A. Environmental Release

No information was found in the secondary sources searched regarding the environmental release of potassium hydroxide.

B. Transport

The significant water solubility of potassium hydroxide suggests that the chemical would be mobile in soil and subject to transport to ground water; however, no evidence was found to confirm this.

C. Transformation/Persistence

1. Air — When exposed to air, potassium hydroxide forms the bicarbonate and carbonate (Pierce 1994a).
2. Soil — No information was found in the secondary sources searched regarding the transformation/persistence of potassium hydroxide in soil.
3. Water — No information was found in the secondary sources searched regarding the transformation/persistence of potassium hydroxide in water.
4. Biota — No information was found in the secondary sources searched regarding the transformation/persistence of potassium hydroxide in biota.

CHEMICAL SUMMARY FOR POTASSIUM PERSULFATE

This chemical was identified by one or more suppliers as a bath ingredient for the electroless copper and non-formaldehyde electroless copper processes. This summary is based on information retrieved from a systematic search limited to secondary sources (see Attachment C-1). These sources include online databases, unpublished EPA information, government publications, review documents, and standard reference materials. No attempt has been made to verify information in these databases and secondary sources.

I. CHEMICAL IDENTITY AND PHYSICAL/CHEMICAL PROPERTIES

The chemical identity and physical/chemical properties of potassium persulfate are summarized below.

CHEMICAL IDENTITY AND CHEMICAL/PHYSICAL PROPERTIES OF POTASSIUM PERSULFATE		
Characteristic/Property	Data	Reference
CAS No.	7727-21-1	
Common Synonyms	peroxydisulfuric acid, dipotassium salt; dipotassium persulfate; potassium peroxydisulfate	HSDB 1995
Molecular Formula	$K_2O_8S_2$	Budavari et al. 1989
Chemical Structure	$ \begin{array}{c} O \quad O \\ \quad \\ KOSOOSOK \\ \quad \\ O \quad O \end{array} $	
Physical State	colorless or white crystals	Budavari et al. 1989
Molecular Weight	270.32	Budavari et al. 1989
Melting Point	decomposes @ 100°C	Budavari et al. 1989
Boiling Point	no data	
Water Solubility	1.75 g/100 mL @ 0°C; 5.2 g/100 mL @ 20°C	HSDB 1995
Density	2.477	Lide 1991
Vapor Density (air = 1)	no data	
K_{oc}	no data	
Log K_{ow}	no data	
Vapor Pressure	no data	
Reactivity	powerful oxidizing agent; aqueous solution is acidic	Budavari et al. 1989
Flammability	may ignite other combustible materials; reaction with fuels may be violent; combustion reaction with metallic dust in the presence of moisture	HSDB 1995
Flash Point	no data	
Dissociation Constant	no data	
Henry's Law Constant	no data	
Molecular Diffusivity Coefficient	no data	
Air Diffusivity Coefficient	no data	
Fish Bioconcentration Factor	no data	
Odor Threshold	no data	
Conversion Factors	no data	

II. ENVIRONMENTAL FATE

A. Environmental Release

Potassium persulfate, a crystalline solid, is moderately soluble in water (Budavari et al. 1989). No data on the environmental release of potassium persulfate were found in the secondary sources searched.

B. Transport

No information on the transport of potassium persulfate was found in the secondary sources searched. The water solubility of potassium persulfate suggests that the chemical would leach through soil.

C. Transformation/Persistence

No information on the transformation/persistence of potassium persulfate in air, soil, water, or biota was found in the secondary sources searched.

CHEMICAL SUMMARY FOR POTASSIUM SULFATE

This chemical was identified by one or more suppliers as a bath ingredient for the electroless copper process. This summary is based on information retrieved from a systematic search limited to secondary sources (see Attachment C-1). The only exception is summaries of studies from unpublished TSCA submissions that may have been included. These sources include online databases, unpublished EPA information, government publications, review documents, and standard reference materials. No attempt has been made to verify information in these databases and secondary sources.

I. CHEMICAL IDENTITY AND PHYSICAL/CHEMICAL PROPERTIES

The chemical identity and physical/chemical properties of potassium sulfate are summarized below.

CHEMICAL IDENTITY AND CHEMICAL/PHYSICAL PROPERTIES OF POTASSIUM SULFATE		
Characteristic/Property	Data	Reference
CAS No.	7778-80-5	
Common Synonyms	sulfuric acid, dipotassium salt; dipotassium sulfate	HSDB 1995
Molecular Formula	K ₂ SO ₄	Budavari et al. 1989
Chemical Structure	K ₂ O ₄ S	Budavari et al. 1989
Physical State	colorless or white, hard, bitter crystals; or white granules or powder	Budavari et al. 1989
Molecular Weight	174.26	Budavari et al. 1989
Melting Point	1067°C	Budavari et al. 1989
Boiling Point	1689°C	HSDB 1995
Water Solubility	1 g/8.3 mL	Budavari et al. 1989
Density	2.66	Budavari et al. 1989
Vapor Density (air = 1)	no data	
K _{oc}	no data	
Log K _{ow}	no data	
Vapor Pressure	no data	
Reactivity	permanent in air non-reactive	Budavari et al. 1989 JT Baker Inc. 1992c
Flammability	non-flammable	JT Baker Inc. 1992c
Flash Point	no data	
Dissociation Constant	no data	
Henry's Law Constant	no data	
Molecular Diffusivity Coefficient	no data	
Air Diffusivity Coefficient	no data	
Fish Bioconcentration Factor	no data	
Odor Threshold	odorless	Budavari et al. 1989
Conversion Factors	no data	

II. ENVIRONMENTAL FATE

A. Environmental Release

No information was found in the secondary sources searched regarding the environmental release of potassium sulfate. Potassium sulfate is a minor component of pulverized fuel ash (Davison et al. 1986). Potassium sulfate is not one of the chemicals reported to the TRI by certain types of U.S. industries.

B. Transport

No information was found in the secondary sources searched regarding the transport of potassium sulfate, however it is soluble in water and could be expected to move through the environment.

C. Transformation/Persistence

1. Air — Potassium sulfate is water soluble and atmospheric potassium sulfate would be expected to be dissolved in rainwater.
2. Soil — No information was found in the secondary sources searched regarding the transformation/persistence of potassium sulfate in soil.
3. Water — No information was found in the secondary sources searched regarding the transformation/persistence of potassium sulfate in water. Aqueous solutions of potassium sulfate are pH neutral (Budavari et al. 1989).
4. Biota — No information was found in the secondary sources searched regarding the transformation/persistence of potassium sulfate in biota.

CHEMICAL SUMMARY FOR POTASSIUM SODIUM TARTRATE

This chemical was identified by one or more suppliers as a bath ingredient for the electroless copper process. This summary is based on information retrieved from a systematic search limited to secondary sources (see Attachment C-1). The only exception is summaries of studies from unpublished TSCA submissions that may have been included. These sources include online databases, unpublished EPA information, government publications, review documents, and standard reference materials. No attempt has been made to verify information in these databases and secondary sources.

I. CHEMICAL IDENTITY AND PHYSICAL/CHEMICAL PROPERTIES

The chemical identity and physical/chemical properties of potassium sodium tartrate are summarized below.

CHEMICAL IDENTITY AND CHEMICAL/PHYSICAL PROPERTIES OF POTASSIUM SODIUM TARTRATE		
Characteristic/Property	Data	Reference
CAS No.	6381-59-5; 304-59-6; 147-79-5	
Common Synonyms	Rochelle salt; seignette salt	Budavari et al. 1996 HSDB 1996
Molecular Formula	C ₄ H ₄ KNaO ₆	Budavari et al. 1996
Chemical Structure	no data	
Physical State	translucent crystals of white, crystalline powder	Budavari et al. 1996
Molecular Weight	210.16	Budavari et al. 1996
Melting Point	70-80° C	Budavari et al. 1996
Boiling Point	220° C decomposes	Budavari et al. 1996
Water Solubility	soluble in 0.9 parts H ₂ O	Budavari et al. 1996
Density	52% 1.79	Budavari et al. 1996
Vapor Density (air = 1)	no data	
K _{oc}	no data	
Log K _{ow}	no data	
Vapor Pressure	no data	
Reactivity	incompatible with acids, calcium or lead salts magnesium sulfate, silver nitrate	Budavari et al. 1996 JT Baker, Inc. 1992d
Flammability	slight	
Flash Point	none	
Dissociation Constant	no data	
Henry's Law Constant	no data	
Molecular Diffusivity Coefficient	no data	
Air Diffusivity Coefficient	no data	
Fish Bioconcentration Factor	no data	
Odor Threshold	odorless	EM Industries 1992
Conversion Factors	no data	

II. ENVIRONMENTAL FATE

A. Environmental Release

No information was found in the secondary sources searched regarding the environmental release of potassium sodium tartrate. Potassium sodium tartrate is not one of the chemicals reported to the TRI by certain types of U.S. industries.

B. Transport

No information was found in the secondary sources searched regarding the transport of potassium sodium tartrate. It is, however, very soluble in water.

C. Transformation/Persistence

No information was found in the secondary sources searched regarding the transformation/persistence of potassium sodium tartrate in air, soil, water, or biota. It is, however, very soluble in water.

CHEMICAL SUMMARY FOR SILVER

This chemical was identified by one or more suppliers as a bath ingredient for the conductive ink process. This summary is based on information retrieved from a systematic search limited to secondary sources (see Attachment C-1). The only exception is summaries of studies from unpublished TSCA submissions that may have been included. These sources include online databases, unpublished EPA information, government publications, review documents, and standard reference materials. No attempt has been made to verify information in these databases and secondary sources.

I. CHEMICAL IDENTITY AND PHYSICAL/CHEMICAL PROPERTIES

The chemical identity and physical/chemical properties of silver are summarized below.

CHEMICAL IDENTITY AND CHEMICAL/PHYSICAL PROPERTIES OF SILVER		
Characteristic/Property	Data	Reference
CAS No.	7440-22-4	
Common Synonyms	Argentum crede; collargol	U.S. EPA 1996b
Molecular Formula	Ag	ATSDR 1990c
Chemical Structure	Ag; Ag ¹⁺ ; Ag ²⁺	ATSDR 1990c
Physical State	Malleable, ductile, white metal	Budavari et al. 1996
Molecular Weight	107.868	Budavari et al. 1996
Melting Point	960.5°C	Budavari et al. 1996
Boiling Point	2212°C @ 760 mm Hg	ATSDR 1990c
Water Solubility	Insoluble	ATSDR 1990c
Density	10.50 g/cm ³ @ 20°C	ATSDR 1990c
Vapor Density (air = 1)	No data	
K _{oc}	No data	
Log K _{ow}	No data	
Vapor Pressure	100 mm Hg @ 1865°C	ATSDR 1990c
Reactivity	Forms explosive acetylide; forms explosive fulminate compounds with ammonia and with nitric acid + ethanol; reacts violently or produces explosive compounds with bromazide, hydrogen peroxide, ethyleneimine, chlorine, trifluoride, oxalic acid and tartaric acid.	HSDB 1996
Flammability	Moderately flammable as dust	ATSDR 1990c
Flash Point	No data	
Dissociation Constant	No data	
Henry's Law Constant	No data	
Molecular Diffusivity Coefficient	No data	
Air Diffusivity Coefficient	No data	
Fish Bioconcentration Factor	2 - 10	ATSDR 1990c
Odor Threshold	No data	
Conversion Factors	Not applicable, found in air as particulate material	ATSDR 1990c

II. ENVIRONMENTAL FATE

A. Environmental Release

Silver is a naturally occurring element that is present in the earth's crust at an average concentration of about 0.1 ppm and at about 0.3 ppm in soils (ATSDR 1990c). It is also present in unpolluted freshwater at concentrations up to 0.5 ppm and in seawater at about 0.01 ppm (HSDB 1996). Silver is released into the environment from mining and recovery processes, and industrial production processes. It is released into the atmosphere during refuse incineration and from burning of coal and petroleum products. Silver and silver compounds are also released from consumer products (ATSDR 1990c). Products and uses include photography, electroplating, electrical conductors, dental alloys, solder and brazing alloys, paints, jewelry, coins, and mirror construction (Faust 1992a). The largest source of silver release through consumer products is photographic material. Silver in the form of silver iodide has been used as cloud seeding material (ATSDR 1990c). Background atmospheric levels of silver measured in national parks away from industrialized areas are generally

less than 0.2 ng/m³, however, the concentration can be much higher near smelter plants (up to 36.5 ng/m³) or in cloud-seeding target areas (1.0 ng/m³) (ATSDR 1990c). Releases into surface waters have resulted in concentrations up to 38 ppm found in the Colorado River, and concentrations as high as 5 ppm in finished drinking water samples. Sediments in the Genesee River in New York downstream from a plant manufacturing photography supplies were found to contain 150 mg silver/kg dry weight (HSDB 1996).

Releases of silver and silver compounds to environmental media in 1993, as reported to the TRI by certain types of U.S. industries totaled about 8608 pounds of elemental silver and 57,168 pounds of silver compounds. Of these amounts, totals of 7080 pounds silver and 21,623 pounds silver compounds were released to the atmosphere, 318 pounds of silver and 9069 pounds of silver compounds were released to surface water, 210 pounds silver and 100 pounds silver compounds were released in underground injection, and 1000 pounds silver and 20,376 pounds of silver compounds were released to land (TRI93 1995).

B. Transport

Metallic silver released to the atmosphere as particulate material undergoes deposition to land and surface water (ATSDR 1990c). If the particulate material is finely divided (<20 μ diameter), it can possibly travel long distances before depositing resulting in an enrichment of soil silver levels in areas distant from cloud seeding operations or other sources of airborne silver. Large particles (>20 μ diameter) such as released during mining operations are deposited near the source (ATSDR 1990c). Transport of silver in surface waters is dependent upon the particular chemical form of the element. Silver can form a number of complexes and salts under certain aquatic conditions of pH and reactant availability. Some compounds precipitate, some adsorb onto particulate matter, and some are soluble and may travel long distances in solution. Up to 90% of the silver detected in rivers was estimated to be in a dissolved form (ATSDR 1990c). Silver tends to be removed from well drained soils; however, the pH, oxidation-reduction potential, and the presence of organic material can affect the mobility. Iron and manganese complexes can immobilize silver, and organic material adsorbs silver (ATSDR 1990c).

C. Transformation/Persistence

1. Air —Atmospheric silver is in particulate form and is likely to become coated with silver oxide, silver sulfide, or silver carbonate before deposition. Large particles (>20 μ) such as released during mining operations are deposited near the source, whereas finer particles (<20 μ diameter) generated by burning refuse or fossil fuels and by cloud seeding can be carried long distances before being deposited in precipitation (ATSDR 1990c).
2. Soil —Iron and magnesium complexes in the soil tend to immobilize silver and are dependent on pH and oxidation-reduction potential of the soil. Organic matter complexes with silver and also reduces its mobility. The persistence of silver in soils is also dependent on the drainage of the soil and will eventually be removed from well drained soils (ATSDR 1990c).
3. Water —Silver in water exists primarily as the monovalent ion, which can be combined with sulfate, bicarbonate, chloride, and ammonia. It was estimated that about 90% of the silver in rivers is in a dissolved form and the remaining 10% is in suspended solids. Depending on the pH and oxidation-reduction conditions, silver can be adsorbed to manganese oxide, which will eventually be deposited in sediment. It may also become adsorbed onto humic material and suspended particulates. In the presence of decaying animal and plant material, silver precipitates as the sulfide. The sediments in lakes were generally found to be about 1000 times higher in silver concentration than the overlying waters (ATSDR 1990c).

4. Biota —Silver does not tend to bioaccumulate in fish (bioaccumulation factors of 2-10). However, it can be adsorbed by marine algae and accumulated. Bioconcentration factors for marine algae of 13,000 to 66,000 have been calculated (ATSDR 1990c). Silver is absorbed by mussels, clams, and oysters. Bioconcentration factors of 1055 to 7650 have been determined for the marine mussel, *Mytilus edulis*. Biological half-lives of 26.4 and 149.1 days have been estimated for the pacific and American oysters, respectively. It is absorbed from the soil by plant roots and accumulates in the leaves from atmosphere deposition. (ATSDR 1990c).

CHEMICAL SUMMARY FOR SODIUM BISULFATE

This chemical was identified by one or more suppliers as a bath ingredient for the electroless copper, organic-palladium, and tin-palladium processes. This summary is based on information retrieved from a systematic search limited to secondary sources (see Attachment C-1). The only exception is summaries of studies from unpublished TSCA submissions that may have been included. These sources include online databases, unpublished EPA information, government publications, review documents, and standard reference materials. No attempt has been made to verify information in these databases and secondary sources.

I. CHEMICAL IDENTITY AND PHYSICAL/CHEMICAL PROPERTIES

The chemical identity and physical/chemical properties of sodium bisulfate are summarized below.

CHEMICAL IDENTITY AND CHEMICAL/PHYSICAL PROPERTIES OF SODIUM BISULFATE		
Characteristic/Property	Data	Reference
CAS No.	7681-38-1	
Common Synonyms	sodium acid sulfate; sodium hydrogen sulfate sodium pyrosulfate	Budavari et al. 1989
Molecular Formula	NaHSO ₄	Budavari et al. 1989
Chemical Structure	HNaO ₄ S	Budavari et al. 1989
Physical State	Fused, hygroscopic pieces; monohydrate, crystalline	Budavari et al. 1989
Molecular Weight	120.07	Budavari et al. 1989
Melting Point	315 °C	Budavari et al. 1989
Boiling Point	No data	
Water Solubility	50 g/100 mL 100 g/100 mL boiling water	Budavari et al. 1989
Specific Gravity	2.435	Budavari et al. 1989
Vapor Density (air = 1)	No data	
K _{oc}	No data	
Log K _{ow}	No data	
Vapor Pressure	No data	
Reactivity	Corrosive, water solutions are acidic, decomposes by alcohol to liberate sulfuric acid, SO ₂ gas produced when heated to decomposition.	RTECS 1995 Budavari et al. 1989
Flammability	Non-flammable	JT Baker Inc. 1995
Flash Point	No data	JT Baker Inc. 1995
Dissociation Constant	No data	
Henry's Law Constant	No data	
Molecular Diffusivity Coefficient	No data	
Air Diffusivity Coefficient	No data	
Fish Bioconcentration Factor	No data	
Taste Threshold	No data	
Odor Threshold	Odorless	JT Baker Inc. 1995
Conversion Factors	Not applicable, material contained in water aerosol or present as dust	

II. ENVIRONMENTAL FATE

A. Environmental Release

Sodium bisulfate is manufactured for use as a solubilizer for minerals, for pickling metals, carbonizing wool, bleaching and swelling leather, and in the manufacture of magnesia cements (Budavari et al. 1989). It is also used in the agricultural industry as a disinfectant (RTECS 1995). The total number of individuals occupationally exposed to sodium bisulfate in a National Occupational Exposure Survey in 1983 was 151,380 (RTECS 1995).

B. Transport

No information on the transport of sodium bisulfate was found in the secondary sources searched. In areas where the chemical is used, it has been found in airborne dusts and in water aerosols (JT Baker Inc. 1995; Utell et al. 1982). Due to its high water solubility, about 50 g/100 mL (Budavari et al. 1989), transport by water is a possibility.

C. Transformation/Persistence

1. Air — No information on the transformation/persistence of sodium bisulfate was found in the secondary sources searched. Aerosols and dusts in industrial settings are controlled by exhaust ventilation (JT Baker Inc. 1995).
2. Soil — Specific studies on the transformation/persistence of sodium bisulfate in the soil were not found in the secondary sources searched; however, sodium bisulfate is likely to rapidly leach from the soil into ground water because of its high solubility. It is a non-volatile solid and should not volatilize into the atmosphere from the soil, although it may become airborne in dust (JT Baker Inc. 1995).
3. Water — No studies on the transformation/persistence of sodium bisulfate in water were found in the secondary sources searched. Sodium bisulfate is strongly acidic in water solution (Budavari et al. 1989) and, therefore, is subject to neutralization and salt formation by water soluble cations.
4. Biota — No information on the transformation/persistence of sodium bisulfate in biota was found in the secondary sources searched. The water solubility and acidity of sodium bisulfate in solution make bioconcentration unlikely.

CHEMICAL SUMMARY FOR SODIUM CARBONATE

This chemical was identified by one or more suppliers as a bath ingredient for the electroless copper, conductive polymer, and organic-palladium processes. This summary is based on information retrieved from a systematic search limited to secondary sources (see Attachment C-1). The only exception is summaries of studies from unpublished TSCA submissions that may have been included. These sources include online databases, unpublished EPA information, government publications, review documents, and standard reference materials. No attempt has been made to verify information in these databases and secondary sources.

I. CHEMICAL IDENTITY AND PHYSICAL/CHEMICAL PROPERTIES

The chemical identity and physical/chemical properties of sodium carbonate are summarized below.

CHEMICAL IDENTITY AND CHEMICAL/PHYSICAL PROPERTIES OF SODIUM CARBONATE		
Characteristic/Property	Data	Reference
CAS No.	497-19-8	
Common Synonyms	carbonic acid, disodium salt; disodium carbonate; soda ash; trona; Solvay soda	RTECS 1995
Molecular Formula	CNa_2O_3	Budavari et al. 1989
Chemical Structure	Na_2CO_3	Budavari et al. 1989
Physical State	white hygroscopic powder	Pierce 1994b
Molecular Weight	106.0	Budavari et al. 1989
Melting Point	851 °C, but begins to lose CO_2 @ 400 °C	Budavari et al. 1989
Boiling Point	decomposes	Pierce 1994b
Water Solubility	7.1 g/100 mL water @ 0 °C; 45.5 g/100 mL @ 100 °C	Pierce 1994b
Density	2.53 @ 20 °C	Pierce 1994b
Vapor Density (air = 1)	no data	
K_{oc}	no data	
Log K_{ow}	no data	
Vapor Pressure	no data	
Reactivity	decomposed by acids with effervescence; combines with water with evolution of heat; 1% aqueous solution has pH of 11.5	Budavari et al. 1989 Pierce 1994b
Flammability	noncombustible	HSDB 1995
Flash Point	no data	
Dissociation Constant	no data	
Henry's Law Constant	no data	
Molecular Diffusivity Coefficient	no data	
Air Diffusivity Coefficient	no data	
Fish Bioconcentration Factor	no data	
Odor Threshold	odorless	Budavari et al. 1989
Conversion Factors	not applicable	

II. ENVIRONMENTAL FATE

A. Environmental Release

Sodium carbonate is a white hygroscopic powder that is strongly caustic (Pierce 1994b). It is moderately soluble in water (Budavari et al. 1989). It is usually encountered as the decahydrate ($\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$), commonly called washing soda or soda ash (Pierce 1994b). Sodium carbonate occurs naturally in large deposits in Africa and the U.S. as either the carbonate or trona, a mixed ore of equal molar amounts of carbonate and bicarbonate (Pierce 1994b). Naturally occurring hydrates include the monohydrate, thermonitrite, and the decahydrate, natron or natrite (Budavari et al. 1989). Sodium carbonate is used in the manufacture of glass and sodium salts; in soaps and strong cleansing agents; water softeners; pulp and paper manufacture; textile treatments; and various chemical

processes. Sodium carbonate is not listed on the U.S. EPA's TRI, requiring certain U.S. industries to report on chemical releases to the environment (TRI93 1995).

B. Transport

No information on the transport of sodium carbonate was found in the secondary sources searched. The water solubility suggests that the chemical would leach through soil.

C. Transformation/Persistence

No information on the transformation/persistence of sodium carbonate was found in the secondary sources searched. The water solubility suggests that the chemical would remain in the aqueous phase.